10 February 2003

CRUISE RESULTS
Fisheries Research Vessel DELAWARE II
Cruise No. DE 03-01
Ecosystems Monitoring/Acoustics Survey

CRUISE PERIOD AND AREA

This cruise was divided into two parts: Part I was from 13 - 19 January and Part II was from 22 - 31 January 2003. During Part I the FRV DELAWARE II sailed to Halifax, Nova Scotia for an acoustic assessment of underwater radiated vessel noise. During Part II the DELAWARE II covered the Georges Bank and Gulf of Maine regions (Figure 1) for a joint winter dedicated Ecosystems Monitoring and Acoustic survey.

OBJECTIVES

The primary objective of the first part of the cruise was to collect data on vessel noises emanating from the hull while underway with various machinery both running and secured. The primary objective of the second part of the cruise was to assess the changing biological and physical properties of the Georges Bank and Gulf of Maine regions of the northeast continental shelf ecosystem which influence the sustainable productivity of the living marine resources. This work was done in conjunction with the collection of underwater acoustic data.

Secondary objectives of Part II were:

- collection of phytoplankton samples for nitrogen stable isotope ratios,
- collection of samples for zooplankton genetics (genome) studies,
- examination of plankton samples at sea for concentrations of Calanus finmarchicus to correlate with right whale sightings.

METHODS

During Part I of the survey the DELAWARE II sailed to Halifax, N.S., where vessel noise measurements were conducted by FMF Cape Scott/WPNS/UWSR at the Halifax Sound Range, Fergusons Cove, in the Halifax harbor entrance. The sound range consisted of two hydrophones, two observation buildings for visual range and location measurements of the ship, and a main building for data

collection and analysis. Two additional personnel (harbor pilot and Robert Dewey of FMF Cape Scott) were brought on board the Delaware II to facilitate the measurements. They were instrumental in making the trials a smooth process. The vessel noise measurements consisted of a dynamic trial plan with reciprocal runs at 4, 6, 8, and 10 knots. A reciprocal run was two passes between the hydrophones in opposite directions. During the measurements, all bridge and scientific echosounders (including Doppler Speed Logs) were secured. In addition to the above runs, a reciprocal run was conducted at 4 knots with the port trawl winch operating (no wire was let out and the drum was spun to simulate trawling activity), and a reciprocal run was conducted at 4 knots with the "charge pump" turned off and on.

Part II of the survey consisted of 45 randomly distributed stations and 11 selected stations at which the vessel slowed or stopped to lower instruments over the side.

Key parameters which were measured included water column temperature and salinity, ichthyo- and zooplankton composition, abundance and distribution; along-track temperature, salinity, chlorophyll-a fluorescence and standard weather observations.

A double oblique tow using the 61-centimeter Bongo sampler and a CTD was made at all stations. The tow was made to approximately 5 meters above the bottom, or to a maximum depth of 200 meters, at a ship speed of 1.5 knots. Plankton sampling gear consisted of a 61-centimeter mouth diameter aluminum bongo frame with two 333-micron nylon mesh nets. A 45-kilogram lead ball was attached by an 80-centimeter length of 3/8-inch diameter chain below the aluminum Bongo frame to depress the sampler. A digital flowmeter was suspended within the mouth of each sampler to determine the amount of water filtered by each net. The plankton sampling gear was deployed over the port stern quarter of the vessel by means of a conducting-cable winch and a boom. Plankton samples were preserved in a 5 percent solution of formalin in seawater. Tow depth was monitored in real time with a Seabird CTD profiler, which was hard-wired to the conductive towing cable, providing simultaneous depth, temperature and salinity data for each plankton tow.

Seawater temperature, salinity, and chlorophyll-a level, at a depth of 2 meters were continuously monitored along the entire cruise track by means of a thermosalinograph, and a flow-through fluorometer.

The thermosalinograph and flow-through fluorometer were connected to the Scientific Computing System (SCS) installed in the laboratory area of the vessel by Atlantic Marine Center personnel. This system recorded output from the thermosalinograph, and the fluorometer every ten seconds, and gave the data records a time-date stamp from the GPS unit.

Samples for Seabird salinity data calibration were obtained on the 6-12 watch by taking a water sample from 30 or more meters depth using a 1.7 liter Niskin bottle at every fifth or sixth station. Calibration of the thermosalinograph and fluorometer from the surface flow-through system was undertaken on the 6-12 watch following the protocol outlined in the Ecosystem Monitoring Program Operations Manual.

Underwater acoustic data were collected using the Simrad EK500 and EK60 scientific echosounders. The EK500 operated three hull-mounted, split-beam transducers operating at 18,38, and 120 kHz. The Simrad EK60 operated at 38 and 120 kHz. For these data, the EK500 and the EK 60 shared the same 38 and 120 kHz transducers. The EK500 and EK60 were externally triggered at a ping rate of 1 ping per 2 seconds(for each echosounder) using a timing box built by Dr.David Demer (SWFSC). The 38 and 120 kHz transducer cables were connected to a junction box which was synched to the timing box and switched transmit and received signals between the EK500 and EK60 echosounders. The EK500 18 kHz transducer was not connected to the transducer junction box, but was synched with the 38 and 120 kHz systems. Data were collected along all cruise tracks and stations.

EK500 data were logged to the backup SCS server via an ethernet connection using SonarData's Echolog program. The echogram, individual target, navigation, and vessel log data were stored for post-processing using SonarData's Echoview software package. Data were imported to Echoview, bottom echoes and surface noise were removed, and backscatter were scrutinized for macro-zooplankton (i.e., euphausiid) and fish. These data and post-processed file were transferred to a shore-based computer for analysis and archive.

EK60 data were logged to a PC via an ethernet connection. EK60 data were recorded in two formats: raw and processed. Raw data consist of the digitally sampled signals, and processed data are similar to the EK500 data formats. The EK60 system is the next-generation scientific echosounder, and the purpose of collecting the EK60 data was to be able to compare these data to the EK500. In addition, because the EK60 is a new system, effort was spent on this cruise to learn the system and data recording and processing capabilities. Thus, raw and processed data were not collected at all times throughout the cruise. These data were transferred to a shore-based computer for analysis and archiving.

Phytoplankton samples for nitrogen stable isotope ratio analysis were collected from the discharge water of the near-surface flow-through system at pre-selected stations. One liter of seawater was pre-filtered through 300 micron mesh nitex gauze to remove most zooplankton, then filtered through a Whatman GFF glass-fiber

filter and immediately frozen for analysis ashore.

Zooplankton genetics samples were collected at five randomly selected stations within each of the two regions using a 20 cm Bongo frame equipped with two 165-micron mesh nets attached to the towing wire 30 cm above the CTD with a wire stop. The samples were preserved in 95% ethanol which was changed once after 24 hours.

Plankton samples were examined for presence of large quantities of Calanus finmarchicus, measured for total settled volumes according to the protocol set forth in Appendix 1. and the results forwarded to Patricia Gerrior, the Northeast Region's Right Whale Sighting Coordinator.

RESULTS

A summary of routine survey activities is presented in Table 1. The areal coverage achieved during the cruise is depicted in Figure 1. In Part I the DELAWARE II departed Woods Hole on January 13, 2003 and commenced steaming to Halifax, Nova Scotia to conduct underwater radiated vessel noise measurements. The vessel arrived in Halifax on January 15 and commenced vessel noise measurements at approximately 0630 EST on January 16. Twelve reciprocal runs as described in the methods section were completed within 6 hours. Upon their completion the two Canadian personnel disembarked from the vessel, and the DELAWARE II returned to Woods Hole, arriving at the NMFS dock by Saturday morning on January 18. A detailed report of the DELAWARE II's radiated noise is being prepared by Michael Jech.

The DELAWARE II returned to sea for Part II of the cruise at 1430 EST on Wednesday, January 22, 2003 and proceeded north through the Cape Cod Canal to commence sampling operations in the Gulf of Maine. Departure had originally been scheduled for January 20 but was delayed due to a large storm system. Despite the diminishing winds, gusts of up to 30 knots and low air temperatures of -12^{0} C. necessitated slow steaming to the first stations off Boston to reduce icing of the vessel after emerging from the Cape Cod Canal. Work commenced on Thursday, January 23. Although winds diminished, low air temperatures of -16^{0} C. caused deck icing to be a continuing problem. Another front with strong winds moved through the area on Friday, further slowing progress as the DELAWARE II sampled stations in the eastern portion of the Gulf of Maine. A weekend of calmer, warmer weather enabled the vessel to complete the remaining Gulf of Maine stations by Sunday night, 26 January so that by Monday morning, work commenced on the northeast peak of Georges Bank. Another bout with strong but warmer winds again slowed progress, forcing the vessel to jog westward towards a station located on the southern flank of Georges Bank. Conditions were so bad upon arrival that an attempt to deploy the plankton sampling gear was

aborted, and the vessel jogged north to a station located on the central part of the Bank, where slowly ameliorating conditions made it possible to resume work by mid-morning on Tuesday, 28 January. Conditions continued to improve, allowing for completion of all stations on Georges Bank by Thursday evening. The DELAWARE II then steamed to Woods Hole via Great Round Shoal and docked at the NMFS pier on Friday morning 31 January 2003, having completed all standard and optional stations, plus conducted acoustic measurements despite the loss of several days of work due to weather. The outstanding success of this cruise was due to the flawless performance of all equipment on board, in sharp contrast to a similar cruise in the fall which was plagued by time-consuming termination problems. Despite the much more severe environmental conditions that were faced on this cruise, there was no down-time owing to any equipment problems, and that was the factor that made the difference for this survey.

DISPOSITION OF SAMPLES AND DATA

All the zooplankton samples and data, were delivered to the Ecosystems Monitoring Group of the NEFSC, Narragansett, RI, for quality control processing and further analysis. The zooplankton genetics samples were picked up from the DELAWARE II by Nancy Copley of the Woods Hole Oceanographic Institution, and the CTD data was delivered to the Oceanography Branch of the NEFSC, Woods Hole, MA with copies of the CTD logs and header file going to the Ecosystems Monitoring Group in Narragansett. The nitrogen isotope samples were kept frozen and delivered to Rick McKinney at the US EPA Lab in Narragansett, RI. All the underwater acoustic data were transferred to a shore-based computer for analysis and archiving by Michael Jech.

SCIENTIFIC PERSONNEL

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Table 1. STATION OPERATION REPORT FOR CRUISE DE0301

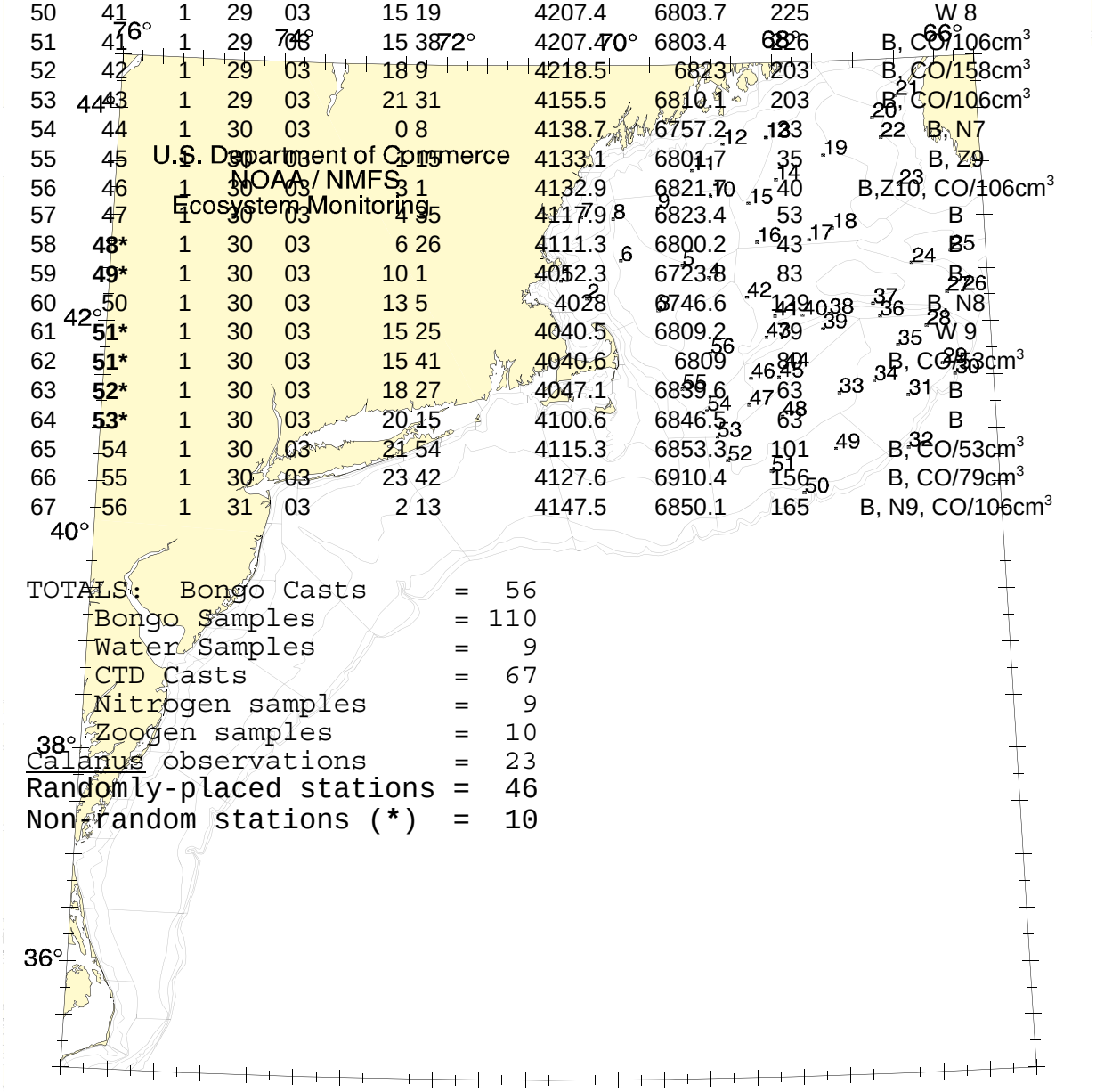
CAST	STA.	Date(GMT)			TIME(GMT)		LAT	LONG	DEPTH	OPER.
N=nitrogen		mm	dd	yy	hr	min			m	(B=bongo W=water Z=zoogen CO/=Calanus observed/vol
1	1	1	23	03	13	21	4228.8	7036.2	76	B, N1
2	2	1	23	03	15	31	4218.7	7017.5	30	B
3	**3***	1	23	03	19	38	4211.9	6926.5	190	B
4	4	1	23	03	23	21	4229.8	6849.7	201	B
5	5	1	24	03	1	23	4236.9	6908.8	191	B, Z1
6	6	1	24	03	5	28	4239.9	6953.0	225	B, CO/211cm^3
7	7	1	24	03	13	53	4304.2	7021.3	102	B, N2
8	8	1	24	03	15	59	4303.5	6958.2	182	B, Z2, CO/53cm^3

9	9	1	24	03	19 32	4309.2	6925.7	148	B, CO/79cm^3
10	10	1	24	03	23 36	4315.6	6847.3	139	W 1
11	10	1	24	03	23 47	4315.5	6847.2	139	B
12	11	1	25	03	2 50	4330	6900.9	134	B, Z3
13	12	1	25	03	5 52	4344.5	6837.8	127	B (no samples)
15	13	1	25	03	10 33	4347.6	6805.8	155	B, CO/106cm^3
16	14	1	25	03	13 10	4323.9	6759.6	242	W 2
17	14	1	25	03	13 37	4323.9	6759.6	241	B, CO/106cm^3
18	15	1	25	03	15 53	4310.9	6820	192	B, CO/106cm^3
19	**16***	1	25	03	18 37	4249	6814.6	194	B, CO/132cm^3
20	17	1	25	03	21 40	4249.6	6737.2	235	B,N3,CO/158cm^3
21	18	1	25	03	23 32	4255.8	6720.6	243	W 3
22	18	1	25	03	23 54	4255.6	6719.9	243	B, CO/106cm^3
23	19	1	26	03	4 42	4336.9	6724.6	215	B,Z4,CO/158cm^3
24	20	1	26	03	8 21	4356.9	6647.4	113	B
25	21	1	26	03	10 11	4408.9	6629.8	97	B
26	22	1	26	03	12 54	4345.7	6642.1	96	W 4
27	22	1	26	03	13 6	4345.6	6641.9	93	B, N4
28	**23***	1	26	03	16 5	4318.7	6630.2	59	B
29	24	1	26	03	22 2	4234.6	6624	189	B
30	25	1	27	03	0 29	4240.5	6555.8	87	B, Z5
31	26	1	27	03	2 55	4217.7	6548.8	205	W 5
32	26	1	27	03	3 5	4217.7	6548.6	205	B, CO/79cm^3
33	27	1	27	03	4 39	4217.7	6559.7	242	W 6
34	27	1	27	03	5 0	4217.5	6559.8	242	B
35	28	1	27	03	7 24	4159.2	6615.7	79	B
36	29	1	27	03	10 6	4137.7	6605.7	96	B, N5
37	30	1	27	03	11 19	4131.4	6557.2	182	B, Z6
38	31	1	27	03	14 33	4121.1	6631.1	88	W 7
39	**31***	1	27	03	14 43	4120.8	6630.9	88	B
40	**32***	1	27	03	17 34	4052.2	6632.6	590	V
41	32	1	27	03	18 15	4051.5	6632.6	966	B
42	33	1	28	03	20 1	4123.3	6719.6	48	B, N6
43	34	1	28	03	22 51	4129.5	6654.6	65	B
44	35	1	29	03	1 31	4148.8	6636.7	70	B

Table 1. STATION OPERATION REPORT FOR CRUISE DE0301 (continued)

CAST	STA.	Date(GMT)			TIME(GMT)	LAT	LONG	DEPTH	OPER.
									B=bongo W=water Z=zoogen N=nitrogen
		mm	dd	yy	hr min			m	CO/=Calanus observed/vol
45	36	1	29	03	4 43	4205.6	6648.3	66	B
46	37	1	29	03	6 6	4212.7	6652.9	209	B, CO/106cm^3

47	38	1	29	03	9	58	4208	6724.4	151	B, CO/79cm^3
48	39	1	29	03	11	42	4159.5	6729.5	42	B, Z7, CO/79cm^3
49	40	1	29	03	13	21	4207.5	6743.5	192	B, Z8, CO/132cm^3
50	41	1	29	03	15	19	4207.4	6803.7	225	W 8
51	41	1	29	03	15	38	4207.4	6803.4	226	B, CO/106cm^3
52	42	1	29	03	18	9	4218.5	6823	203	B, CO/158cm^3
53	43	1	29	03	21	31	4155.5	6810.1	203	B, CO/106cm^3
54	44	1	30	03	0	8	4138.7	6757.2	133	B, N7
55	45	1	30	03	1	15	4133.1	6801.7	35	B, Z9
56	46	1	30	03	3	1	4132.9	6821.7	40	B,Z10, CO/106cm^3
57	47	1	30	03	4	55	4117.9	6823.4	53	B
58	48*	1	30	03	6	26	4111.3	6800.2	43	B
59	49*	1	30	03	10	1	4052.3	6723.8	83	B
60	50	1	30	03	13	5	4028	6746.6	129	B, N8
61	51*	1	30	03	15	25	4040.5	6809.2	79	W 9
62	51*	1	30	03	15	41	4040.6	6809	80	B, CO/53cm^3
63	52*	1	30	03	18	27	4047.1	6839.6	63	B
64	53*	1	30	03	20	15	4100.6	6846.5	63	B
65	54	1	30	03	21	54	4115.3	6853.3	101	B, CO/53cm^3
66	55	1	30	03	23	42	4127.6	6910.4	156	B, CO/79cm^3
67	56	1	31	03	2	13	4147.5	6850.1	165	B, N9, CO/106cm^3



TOTALS: Bongo Casts = 56
Bongo Samples = 110
Water Samples = 9
CTD Casts = 67
Nitrogen samples = 9
Zoogen samples = 10
Calanus observations = 23
Randomly-placed stations = 46
Non-random stations (*) = 10

Figure 1. Station locations numbered consecutively for Part II of Winter Ecosystems Monitoring/Acoustics Survey Cruise DE 03-01, 22 - 31 January 2003. Part I - Halifax Trip, not shown.

Appendix 1.

Protocol for visually estimating total settled volumes of Calanus finmarichicus in plankton samples stored in cylindrical glass quart jars.

At the Narragansett Laboratory, sample jars from Ecosystem Monitoring cruises were measured for settled height of zooplankton where Calanus finmarchicus was the dominant organism present. Dominance was defined as Calanus comprising more than 75% of the sample visible to the eye through the glass sides of the jar. These settled zooplankton heights of >75% Calanus

finmarchicus were multiplied by the cross-sectional area of the quart sample jars (52.8 cm^2) to produce an estimate of the total settled volume in cm^3 of Calanus finmarchicus for comparision between stations that were sampled on the cruise. Note that this method does not take into account the amount of water filtered by the net. It merely expresses an estimate of total volume per tow.

settled height of zooplankton where C. finmarchicus > 75% X cross sectional area of qt jar (52.8 cm^2) = estimated vol C. finmarchicus

This protocol was devised as a method of identifying stations where large quantities of Calanus finmarchicus are located and provides a means for comparing relative abundances of this organism between these high volume locations. Since the method only involves the visual inspection and measurement of the settled plankton samples through the glass walls of the sample jars, the examination may be conducted at sea and the information relayed to shore before the research vessel returns to its home port, making the near-real-time data useful to researchers looking for areas where right whales may be prone to congregating.